CASE STUDY

NO: 003

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Turf Queensland
Grow Green

Monitoring Sediment Loss in Turfgrass Production

Background

Many turf producers would not be aware of the extent of soil and associated nutrient losses that can occur from their property. Rates of soil loss on turf farms are comparable to those of other agricultural industries. However, unlike other enterprises, the product is a ground cover, which is known for its ability to stabilise potentially erosive areas, therefore preventing sediment movement. Yet, even on turf farms, there are periods in the production cycle when soil loss can be high. These include fallow areas prior to replanting and newly harvested areas.

A sediment monitoring demonstration area was set up at a turf farm located in the Gold Coast hinterland, Queensland. It ran during the summer of 2010-2011, a time characterised by sustained rainfall and a number of high intensity rainfall events, accompanied by widespread flooding in South East Queensland. The objective was to demonstrate the extent of sediment and associated nutrient movement on adjacent slopes that were either fully turfed, left bare or sprigged.

The Site

The demonstration area was located on a medium NNE-facing slope. The soil was a highly erodible loam to sandy-loam with a depth of approximately 10 cms and a clay underlay. At the bottom of the slope, the clay layer showed signs of mottling, indicating poor drainage and/or water fluctuation in the profile. The site sloped towards a dam, which acted as a retention pond for on-farm runoff. Beyond the dam lay Canungra Creek, which forms part of the Albert River catchment.

Site treatments

Three management practices were applied to a fallow slope on 6 January 2011 in the following order:

1. Covered in rolls of turfgrass (excepting one upslope strip), no fertiliser applied
2. Left bare, no fertiliser applied
3. Mechanically sprigged at 5% cover and fertilised at a rate of 315 kg/h with 18:10:9 N:P:K starter fertiliser, containing the herbicide oxadiazon.

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Plate 1: Overview of site on 31 January 2011, showing from left to right, the sprigged area, bare slope and turfed area, with the dam in the background.

The turf cultivar used was *Cynodon dactylon* (green couch) cv. Oz Tuff™.

Plate 2: Oz Tuff™ green couch.

Each treatment area was approximately 300 m^2, (30 m slope x 10 m frontage). The top of the trial area was delineated by a soil mound on the down-ward slope of the wheel track of the centre pivot irrigation system servicing the area. Sediment collection troughs were located at the bottom of each treatment area. Gravel drains and ag-pipe were laid underneath the drainage slot of all troughs to remove water from the channels.

Soil collected in the trough was periodically cleared. Soil loss from each treatment was determined from the volume of soil collected in each trough (measured in buckets), adjusted for its water content. This was then converted to soil loss per hectare based on the size of the collection area. A single grab sample was taken for nitrogen from runoff collected from the troughs after a heavy rainfall event on 10 January 2011. A one-off sub-sample was taken to determine the phosphorus content of collected sediment on 31 January 2011.

The growth of the sprigged area was monitored using a percentage estimate made by averaging ten quadrant readings. As small amounts of turfgrass also took root on the bare sloped area, this too was monitored.

Plate 3: Coverage in sprigged area: (a) 31 January 2011, 11% ground cover (b) 14 February 2011, 48% ground cover, (c) 28 February, 86% ground cover.

What we found

Soil Loss

High intensity rainfall events in early January incurred substantial soil losses (17.5–19.5 tonnes/hectare) on the bare earth area and the newly sprigged area. Fully turfed areas, even prior to becoming firmly rooted (normally around 2.5 weeks), were effective in preventing sediment movement. During these rainfall events, the slope covered with natural turfgrass mats was **100 times** more effective in retaining soil than exposed soil (Figure 1). This resulted in an additional 17–19 tonnes per hectare of soil being retained on the covered slope for each rainfall period. In late February a similar effect was seen, with an additional 10 tonnes per hectare retained by the sprigged slope at 86% ground cover and over 12 tonnes per hectare retained by the full sod area.

This 100 fold difference between bare earth soil losses and full turf cover was also true for the term of the monitoring period (Table 1).

Table 1. Cumulative soil losses during the monitoring period 6 January 2011 to 28 February 2011.

	Bare earth	**Sprigged Area**	**Full sod**
Slope	7.3°	6.4°	**7.5°**
Cumulative soil loss (tonnes/hectare)	**60.5**	**35.8**	**0.55**

Plate 4: Collection troughs after heavy rainfall. (a) Sprigged area (86% ground cover), trough has captured some sediment and the drain is blocked. Background: centre pivot irrigation system. (b) Unplanted area (coverage 8% from regeneration), trough has captured a large amount of sediment after a high intensity rainfall event. (c) Fully turfed area, trough has captured a very small amount of sediment.

Later data (Figure 1) demonstrates the increasing effectiveness of the sprigged area as the grass becomes established. Five weeks after sprigging, soil losses in the sediment monitoring troughs are substantially

reduced compared with the bare earth area, as soil loss rates fell towards those achieved by the full sod area. Even at 11% ground cover, the sprigged area retained 2.7 tonnes/ha soil following 87.5 mm rainfall. At 48% ground cover, 3.5 tonnes/ha soil was saved following 30.5 mm rainfall. By 86% ground cover, the sprigged area retained an additional 10 tonnes/ha of soil after 119 mm of rainfall, compared with the exposed slope. The later rainfall period included an intense storm on 21 February, when 66 mm fell in less than 30 minutes.

Rainfall and irrigation data (Figure 2) for the period show high rainfall intensities in the early and later parts of the trial period. The reduced amount of soil lost on the newly sprigged area on 8 January is likely to be attributable to the soil being worked over, improving its infiltration rate. This effect was all but gone within five days, highlighting that surface sealing of exposed soils occurs rapidly and that cultivation is unlikely to prevent runoff. The data collected on 13 January 2011 reflects a saturated soil profile and was accompanied by widespread flooding in the local area and South East Queensland.

The bare slope area showed obvious and worsening damage from sheet and rill (channel) erosion during the monitoring period (Plate 5).

Plate 5: Unplanted area, showing sheet and rill erosion (left) and adjacent turfed area (right), 31 January 2011.

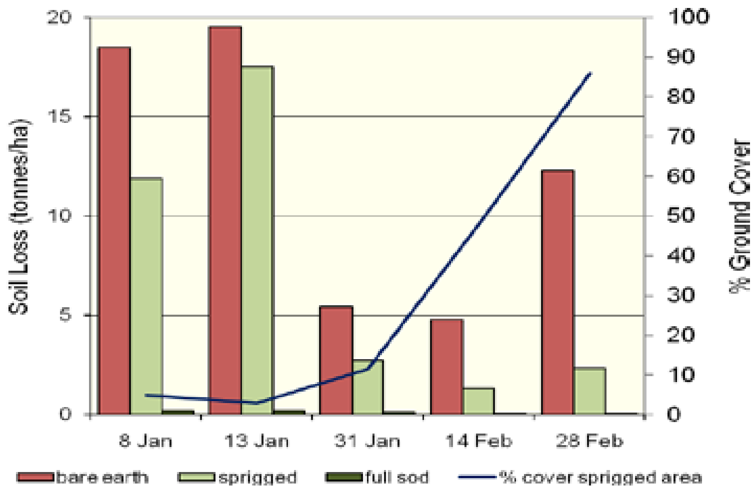
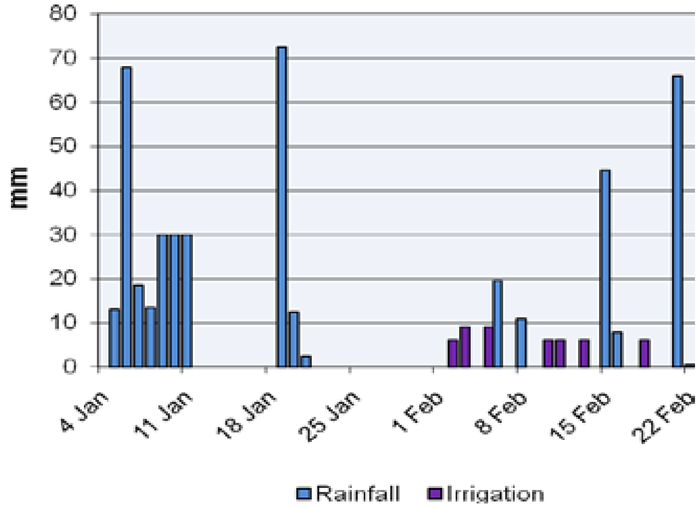


Figure 1: Soil loss rates on an erosive slope with different levels of turfgrass cover in the 2010/2011 summer, Gold Coast Hinterland, Queensland.

Figure 2: Rainfall and Irrigation.
Sediment trapping



On 31 January a breakthrough area was found on the bund adjacent to the full sod area. Sediment from a bare area upslope entered the demonstration area. The ability turfgrass to trap sediment was well illustrated, as the wash area tapered away at 6.5 metres (see Plate 6). As a result, the soil was retained on the slope, and the sediment levels in the monitoring trough remained low.

Plate 6: Sediment from a bare area upslope was retained by the full-cover turfgrass after the bunding was breached. The washout ceased at 6.5 metres.

Nutrient Loss

Spot nitrogen (nitrite plus nitrate) readings were taken in runoff water on 10 January 2011 (Table 2). The lower nitrate reading on full sod may reflect a reduction in contact between soil and the water flowing off the slope.

Table 2: Nitrite plus nitrate (NO_x) readings from a single grab sample 10 January 2011.

Bare earth	Newly Sprigged Area	Full sod
2.5 mg/L	2.4 mg/L	1.3 mg/L

These readings verify that nitrogen losses are occurring in run-off water and suggest that the turfgrass may be retaining nitrogen that would otherwise have found its way into runoff water. Further trial work would be required to confirm this.
Phosphorus is an element which can be readily moved off-farm attached to soil. A spot sample of soil from the monitoring troughs was taken on 31 January 2011 to measure the phosphorus and potassium levels in sediment.

The levels of phosphorus in collected sediment were very high (>40 mg/L Colwell phosphorus) in all troughs (Table 3). This is most likely due to the relatively high levels of fertiliser applied in the course of turfgrass production. Chicken litter was used two years ago and this is known to release phosphorus slowly over a two to three year period.

Potassium losses on sediment occurred (Table 3). These should be considered as minimum figures, as further losses of water soluble potassium would have taken place in runoff water.

Table 3: Predicted phosphorus and potassium losses in sediment.

	Bare earth	Sprigged Area[1]	Full sod
Colwell phosphorus 31 January 20011	150 mg/kg	90 mg/kg	**190 mg/kg**
Cumulative soil loss to 28/2/11	60.5 tonnes/h	35.8 tonnes/h	**0.55 tonnes/h**
Estimated cumulative phosphorus loss	9.1 P kg/h	3.2 P kg/h	**100 g/h**
Available potassium	78 mg/kg (low)	60 mg/kg (low)	**90 mg/kg (med)**
Estimated minimum potassium loss	**4.7 K kg/h**	**2.15 kg/h**	**50 g/h**

[1] Drains on this trough were totally clogged and the sample was saturated. This may have under-represented phosphorus and potassium levels in this treatment.

The loss of applied product (measured as phosphorus) was also reflected in a breakdown of weed control on the sprigged area. Much of the applied oxadiazon (Ronstar), would have migrated off-slope and into the monitoring troughs. Oxadiazon is strongly adsorbed onto soil particles.

For every tonne of soil lost an average of $7.65 worth of starter fertilizer[2] washed away. During the monitoring period in January and February, this equated to monetary losses of $463 per ha in the bare earth area and $274 per ha in the sprigged area, but only $4.20 in the fully turfed area.

Due to the unexpectedly high levels of sediment movement, drains on the bare earth area and the sprigged area (in particular) were blocked by 31 January 2011. The high levels of nutrient movement from the exposed slopes were verified by algal films on soil and in water in troughs collecting sediment and runoff water from the sprigged and bare earth areas. No algal films or blockages were found in the collection trough for the fully-turfed area.

Implications

High levels of soil and nutrient loss are costly to the producer.

- Soil lost due to erosion is normally valuable surface soil, with the structure, organic matter content and nutrients required for turfgrass growth and sustained production. Once soil movement has occurred, it is difficult to replace.
- Shallow soils reduce the yields of high quality turf with good sod-strength.
- Repairing damaged slopes and unblocking drains and sediment traps is expensive.
- Costly fertilisers and agricultural chemicals are washed away.
- Sediment and nutrient loss also affects local waterways. In addition to causing environmental damage, producers can be exposed to the risk of litigation.

The demonstration shows that turf mats afford exposed erosive slopes almost instant protection from rainfall events. Sod was **100 times** more effective in keeping soil in place than exposed soil during the monitoring period. Every bit of turf cover made a difference—as the sprigged area grew, the amount of soil retained on the site increased.

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[2] Based on elemental phosphorus losses applied as a complete fertiliser mix, with a herbicide. Cost of elemental phosphorus: $53.52 per kg.

Producer Strategies to Protect Soil

- Sprig vulnerable slopes prior to intense rainfall periods (October to March in South East Queensland). Full slope protection can be achieved in around eight weeks for a modest net cost, with the product harvested during the cooler parts of the year.
- Steeper slopes require extra care to reduce the time that they are left unprotected throughout the summer rainfall period. On steep slopes, if possible, schedule harvesting and replanting away from intense rainfall periods to reduce sediment and nutrient movement in runoff water. Where erosive damage occurs, this is costly to repair.
- Contour banks and turf buffer strips left on the contour, are other tools to assist with sediment and nutrient retention on erosive slopes.

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